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SOCIETY OF TROPICAL MEDICINE AND HYGIENE.

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VOLUME XII. No. 3.

Proceedings of a Meeting of the Society held on Friday, January 17th, 1919, at 5.30 p.m., at 11, Chandos Street, Cavendish Square, W. 1., Surgeon-General Sir DAVID BRUCE, K.C.B., F.R.S. (*President*), in the Chair.

MALARIA CONTRACTED IN ENGLAND.

BY LIEUT.-COL. S. P. JAMES, I.M.S. (ret.).

The principal observations on malaria contracted in England, which were made during 1917, were published last June in a collection of reports to the Local Government Board. It will be remembered that the total number of locally contracted cases reported among all classes of the population in that year was 178, of which 19 were in the Navy, 136 in the Army, and 23 in the civil community. The experience of malaria contracted in England in 1918 will be similarly published by the Local Government Board in due course, but I am permitted to make a general reference to its known extent and distribution in the civil population, to be supplemented by the contributions which are promised to the Society in regard to naval and military data.

The following statement gives the number of civilian cases of malaria which are at present known in this country, with the localities in which they were detected. The total

is 67, of which it is believed that 43 were contracted in 1917, or earlier, and 24 in 1918 :—

SUMMARY OF KNOWN CIVILIAN CASES.

County.	Place.	Contracted in 1917 or earlier.	Contracted in 1918.	Totals.
Suffolk	Southwold	1	0	1
Essex	Tilbury	3	0	3
,, ...	Walton-on-Nase	2	1	3
,, ...	Dovercourt	1	1	2
Kent	Queenborough	27	5	32
,, ...	Sheerness	0	2	2
,, ...	West Minster	0	4	4
,, ...	Sheppey (Rural)	8	3	11
,, ...	Isle of Grain	0	6	6
,, ...	Sandwich	1	1	2
Salop	Shrewsbury	0	1	1
		43	24	67

It will be seen that most of the cases occurred in north-east Kent, near the mouth of the Thames, an area comprising the Isle of Grain and the Isle of Sheppey—which includes the rural district of that name,—the town of Sheerness, the small borough of Queenborough and the hamlet of West Minster. In regard to the cases in these localities and in Essex I give the following information :—

Queenborough town.—In Queenborough town, at the beginning of 1918, there were eleven residents who had been notified as having contracted malaria during 1917. By visits to the town and the appointment of Dr. SEELLY as Special Malaria Officer on the civil side, these cases were kept under continuous observation, and in April and May, when several of them suffered from relapses, they were provided with medical attendance and treatment and with mosquito curtains free of cost. When these arrangements became known, several other persons, whose cases had not previously come to notice, reported themselves to Dr. SEELLY, so that by the end of May the number of known cases had risen to eighteen. Systematic enquiry for cases and the taking of blood films were then begun, with the result that, by the end of the year, the total number of malaria patients known in the town amounted to thirty-two, of whom it is believed all except five had their first attack in 1917 or previously. Of the new cases, one was discovered on the 23rd July, the remaining four in October.

Sheerness town.—In 1917 no case of malaria was reported from the town, but in 1918 there were two, both being believed to be new infections. Both were discovered early in September.

West Minster.—This is a small village consisting of two rows of houses alongside the railway about midway between Queenborough and Sheerness. In 1917 no new case was reported from the village, but in 1918 there were four, of which one occurred in August, two in September and one in October.

Sheppey Rural District.—In 1917, in the area called Sheerness East, which adjoins Holm Place Hutment Military Camp, eight cases were found. Three new cases were reported in 1918—one in July, one in August and one in September.

The Isle of Grain.—During the week ending October 5th, 1918, two cases of malaria were detected by Surgeon HULL, R.N., among civilians in the Hoo Rural District. The patients were two children, aged 1½ and 7 years, in a cottage a few hundred yards from the headquarters of the R.A.F. Station in the Isle of Grain. At a visit of enquiry on the 15th October, three other cases came to notice, and Surgeon HULL reported a sixth case on November 1st.

Sandwich.—There was one civilian case in 1917, and one civilian case has been detected in 1918.

Essex.—Enquiries made by Lieut.-Col. WILKINSON in Essex have brought to notice seven cases of locally contracted malaria, namely, three at Tilbury, two at Dovercourt, in the Harwich Urban District, and two at Walton-on-the-Naze. Apparently five of the seven cases were contracted in the autumn of 1917, but they were not discovered until they relapsed in 1918.

I may now refer to the following subjects of epidemiological and clinical interest in connection with the cases in the north-east Kent area.

The 1917 epidemic in Sheppey.

In 1917, nearly all the locally contracted civilian cases which were discovered in England occurred in the Queenborough and Sheerness area of the Isle of Sheppey as part of a well-marked epidemic which affected both troops and civilians in that locality. According to our present information, the total number of civilian cases in that outbreak was 35, of which eight occurred in close association with the military cases at the Holm Place Hutment Camp, and 27 occurred in Queenborough town. The epidemic prevalence of malaria in the locality was first detected among soldiers in the Holm Place Camp, and the origin of the new military cases there was attributed to the presence in the camp of many malaria infected soldiers who had returned from Salonika. The new infections among the troops were with the Salonika strain of the benign tertian parasite, and the occurrence was an outbreak, not of indigenous malaria, but of exotic malaria, due to importation of the Salonika parasite. It seemed clear also that the civilians who lived within or in the immediate vicinity of the camp were also infected with the Salonika strain of the parasite, for their illnesses were of the same severe type as those of the military cases, and the incidence of the disease among them, as regards time and place, could be explained only on that view. We concluded, therefore, that in the Holm Place area, as regards both troops and civilians, we had to do solely with a newly imported exotic infection, not with an infection which could be correctly styled indigenous.

But when the investigation was extended to Queenborough town we found cases which could not be ascribed with probability to an origin from military foci, and although in these cases, as in those near Holm Place, the parasite was of the benign tertian variety, the clinical symptoms and signs were much milder. Moreover, the detailed enquiries which were made in all these civilian cases enabled us to refer some of them to an origin from other civilian cases in their immediate neighbourhood, and in a few instances to civilian cases which had originated before troops began to return from Salonika. On these findings, and with the local knowledge that as late as 1865–70, "nearly everyone in Queenborough suffered from ague," it appeared probable that in this instance the infections were with the indigenous strain of the parasite which had never entirely disappeared from the town, and that the condition in 1917 was an epidemic rise of prevalence in a locality where true indigenous disease was already endemic.

I think therefore that in the Sheppey outbreak of 1917, there were two independent foci, one (originating at Holm Place) being a focus of exotic malaria, the other (originating in Queenborough town) being a focus of true indigenous malaria.

During the last three months of 1918, we had an opportunity of observing in the Isle of Grain a similar but smaller outbreak of true indigenous malaria, which in this instance occurred in the absence of any malaria infection among neighbouring troops or naval garrison. I refer to the six cases which I have already mentioned as having been detected in the small village of Grain. The outbreak was among four families living in a row of dilapidated cottages near the Royal Air Force Station. The occupants of one of the cottages numbered six, of whom three (it was said) had suffered from ague in previous years. One of them was an old lady, who gave a quite accurate account of both tertian and quartan ague, and described the relapses from which she used to suffer. She said that most of the local inhabitants had had ague at one time or another, and that as a rule they did not call in a doctor, but treated themselves with quinine powders or pills

bought from a chemist. Among the personnel of the Air Force stationed in the locality there was no old case of malaria and no new case had occurred.

As a contrast to this example, I may mention a small outbreak of locally contracted malaria which occurred in 1917 among troops in Aldershot area. This was clearly an example due exclusively to the importation of the exotic disease, and it was confined to cases of infection with the exotic strain of the parasite. It did not spread to civilians, and so far as we have been able to ascertain the indigenous disease does not occur in the area.

From these observations, I think it may be inferred that as regards malaria in England, we have to deal with two different, and as a rule, independent conditions: the one arising from the importation of exotic malaria and due to a foreign strain of the parasite, the other being true indigenous malaria, due to a parasite which has never entirely disappeared from this country.

Clinical differences between the exotic and the indigenous disease in England.

It is unfortunate that we are not as yet able by blood examination to ascertain whether a patient is infected with the exotic or with the indigenous race of the benign tertian parasite, but clinically there is, as a rule, a considerable difference between the two classes of case. The civilians who were infected at Holm Place Camp (undoubtedly with the Salonika parasite) were seriously ill and suffered many relapses. But civilians infected in Queenborough town (presumably with the indigenous parasite) suffered only very mild attacks, and relapses have been rare. Indeed many of these cases would have escaped discovery if house-to-house enquiry and the routine taking of blood films had not been the rule. A number of examples indicating the mildness of type of the indigenous disease came to our notice. Mrs. ——, of Castle Street, Queenborough, was discovered during a routine examination of all the occupants of the house. She said that "occasionally she had cold shivers, but did not take much notice of them." She had not at any time ceased to carry on her usual work. Parasites were present in her blood. Agnes C——-, aged 13, of Harold Street, Queenborough, answered the door when we visited the house and was engaged in helping her mother with house-work. She appeared bright and cheerful, but her mother said she was paler than usual, and that she intended to send her to Guildford for a change. We took a blood specimen and found a considerable number of parasites in it. The parents of one of the affected children at Grain were treating him with small doses of ammoniated tincture of quinine, because they happened to have it in the house, and it did not seem worth while buying quinine powders as the case was mild.

These experiences are very different from those of civilian patients who were infected with the exotic (Salonika) strain of the benign tertian parasite. It suffices to mention that in at least three of the civilian infections contracted at Holm Place Camp, the patients were so alarmed at the severity of their illness, that they left the district as soon as they were sufficiently recovered to do so.

At present I must be content to record, without attempting to explain, the observation that true indigenous malaria in England is now a milder disease than formerly, and a milder disease than that is exotic malaria contracted in England. The practical importance of the observation is, first, from the point of view of patients, that it is certainly preferable to be infected with the indigenous parasite rather than with the exotic type; second, that for ascertaining the incidence of the indigenous disease and for the purpose of a campaign against it, it is not sufficient to rely upon a system of notification based on clinical symptoms—especially when those symptoms do not alarm people to the degree that makes them willing to go to the expense of calling in a doctor. Our experience in Sheppey shews that for the discovery and prevention of cases of the indigenous disease, the first step should be the provision of free medical attendance and quinine; the second, the institution of special enquiries in every area in which the occurrence of the disease may be suspected.

Indigenous Malaria a Household Disease.

I now refer to some observations in connection with the spread of the indigenous disease in Queenborough town. The cases were not scattered in a random manner throughout the town, but were definitely localised to certain streets and houses. Most of them were in three groups, namely: (1) the Harold Street and Stanley Avenue group, (2) the Comyn Terrace group, and (3) the Castle Street and Woodhall Terrace group. In Harold Street there were cases in the houses numbered 19, 27, and 29; in Comyn Terrace in the houses numbered 1, 4, and 6; in Woodhall Terrace in those numbered 2, 5, and 12; and in Castle Street in those numbered 20, 24, 25, 26, 27, and 32. The localised character of the distribution is more clearly indicated by the incidence of cases in particular houses; and on this subject the findings provide some striking examples of "malarious houses" quite comparable to the well-known instances of "yellow fever houses," which were such a puzzle to epidemiologists before yellow fever was known to be carried by the domestic mosquito, *Stegomyia fasciata*. In No. —, Castle Street, there have been five cases at intervals during 1917 and 1918; in another house there have been three cases, and in four houses there have been two in each. In the first of these houses the occurrence of cases at intervals suggested the need for a blood examination of all the occupants. This was done on July 18th, 1918, and the landlady, Mrs. ——, whose case has already been mentioned, was found to be an apparently healthy malaria carrier. Unknowingly she was probably the original source of infection to several lodgers in her house.

The strictly localised character of the distribution of cases in the town, and particularly the incidence in houses, indicates that the species of mosquito concerned has the habit of remaining most of its life within or in the immediate vicinity of the house where it obtained its first meals of blood. It will be very fortunate if further knowledge of the habits of this species enables us to classify it among the strictly household or domestic mosquitoes against which effective measures are practicable. I hope that Mr. GROVE will supply further notes of the habits of this mosquito in this respect.

Relapses and Anopheline Conditions.

On the subject of relapses in cases of indigenous malaria, I have to note that among 20 cases, continuously observed since their original attack in 1917, 6 had no relapse during 1918, and that among the remaining 14 cases there were 19 relapses, of which 3 occurred in April, 7 in May, 4 in July, 4 in August and 1 in September. If we can continue to obtain detailed records of relapses among all new infections, the results may be of some assistance in an attempt to forecast the next epidemic year. To the same end Mr. GROVE has obtained numerical records of the anopheline conditions in each month of the year in different localities. It is important that in Queenborough in 1918 careful search failed to reveal the presence of any adult anopheles in the houses during April and May, when most relapses occurred. During the first week of June a few male and female adults of the first brood were found in stables, but the number increased slowly, and it was not until July 18th that adults were first found in dwelling-houses in the town. One conjectures that in Queenborough during 1918 there would have been more new cases of malaria if the emergence of the first brood of adult mosquitoes had coincided with the spring rise in relapses.

All the observations I have narrated relate solely to infections through the agency of *maculipennis*, which is the only species concerned with the spread of malaria in Queenborough. The role of *bifurcatus* and *plumbeus* in the spread of malaria in England has still to be worked out, and upon it I have no observations to record this evening.

Perhaps other members can help us with definite observations on this subject.

Measures.

On the civil side, the measures taken in 1918 to deal with the disease were based on an endeavour to discover and control cases and carriers as early as possible. For this

purpose compulsory notification of cases has been supplemented since May by making personal enquiries and taking blood films in households and at school inspections. On the discovery of a case or carrier, steps are taken to ensure :—

(*a*) That the patient during the attack shall rest in bed five days, taking 30 grains of quinine a day.

(*b*) That thereafter he shall take 30 grains of quinine once every ten days for three months.

(*c*) That he is supplied with a proper mosquito curtain, is taught how to use it, and regularly sleeps under it.

(*d*) That the patient and other occupants of the house make a practice of killing all adult mosquitoes which they find in the bedrooms and other rooms of the house.

Patients are visited daily during the first five days and thereafter every tenth day. Surprise visits are also made to ascertain if the curtains are being correctly used. Blood films of all discovered cases are taken at regular intervals.

Discussion.

Mr. A. J. Grove, M.Sc.: Colonel James has asked me to mention some of the results which have been obtained from some investigations which I have been making during the past year for the Local Government Board, upon the prevalence of anopheline mosquitoes. It will be remembered that in the early part of 1918 some information regarding anophelines in England was published in a series of reports submitted by the Local Government Board, and at about the same time the Trustees of the British Museum issued a map shewing the recorded distribution of anophelines in England and Wales up to that time. Useful as this information undoubtedly is it serves to emphasise how little is known of the real prevalence of anophelines, and more particularly our ignorance regarding the habits of the insects under natural conditions in this country; and it was in the hope of throwing some light upon these two subjects that the investigations were commenced.

Three areas were selected (1) Great Wakering in Essex, (2) New Romney in Kent, and (3) Berrington, near Shrewsbury in Shropshire. The first two had each a previous history of malaria and the third had not, and were selected to serve as a sort of control. Each area was visited in rotation every three weeks, and similar investigations were carried out in each.

The first set of observations with which I will deal is an attempt to estimate numerically the prevalence of the adult anophelines in these three areas. Previous experience has shewn that, during the daytime, adult anophelines, particularly *Anopheles maculipennis*, are to be found hiding in cowsheds, stables, etc.; in fact such buildings seem to form their natural diurnal resorts. A number of cowsheds, etc., was selected in each area, and at each visit counts were made in each of them on two days. The method adopted was, after a preliminary search to locate the insects, to record the number which could be counted in half a minute. At the same time a sample of the insects was taken to determine the species present. Curiously enough, although *A. bifurcatus* has been recorded several times from such buildings, yet throughout these observations the only species of anopheline met with in the stables was *A. maculipennis*.

The results obtained were not quite similar, but in general the numbers found gradually decreased until the end of May was reached, but at the beginning of June a sharp increase occurred, which marked the appearance of the new brood. From this point the numbers fluctuated until a maximum was reached about September. (This applies more particularly to the Great Wakering and New Romney areas, while in the case of Berrington the maximum was reached in June, though there was a distinct rise in numbers during September). From the end of September the numbers began to decline.

With regard to *A. bifurcatus* and *A. plumbeus*, numerical observations on these lines

could not be carried out owing to the fact that neither of these insects resort during the daytime to places in which such counts could be made. It may be stated, however, that *A. bifurcatus* has been found, sometimes in numbers, in all of the areas, and *A. plumbeus* at Great Wakering and a locality about three miles from Berrington.

The next set of observations with which I will deal refers to the prevalence of the larvæ. In each of the areas a number of breeding-places was selected, and these were examined at each visit and records kept of the conditions found. It was found impracticable to devise a method by which numerical counts could be made, such as those which had been given for the adults of *A. maculipennis*, but a general estimate was made of the prevalence of the larvæ on each occasion. *A. maculipennis* larvæ were found from the middle of May until the beginning of September. *A. bifurcatus* larvæ were found in decreasing numbers until the end of April, after which they apparently disappeared until the beginning of June, from which time they have been found continuously up to date. *A. plumbeus* larvæ were not found at all, and it is evident that this species does not frequent the type of breeding-place favoured by *A. maculipennis* and *A. bifurcatus*.

From Colonel JAMES's paper it is clear that one of the most important questions upon which knowledge is necessary in connection with malaria in this country, is that of the factors which are concerned with the invasion of buildings, and particularly houses, by anopheline mosquitoes. In this connection it will be useful to refer once more to the results obtained from the periodic counts in the cowsheds, etc. An examination of the individual records shewed that some of the buildings were evidently more favoured by the *A. maculipennis* than others, and from a critical examination of the character of the building, particularly with reference to the character of the roof and the lighting, it has been possible to deduce factors which seem to determine whether a building is likely to be favoured or not. These factors in brief are: (1) the continued use of the buildings by animals; (2) the absence of draughts, particularly near the roof; (3) comparative stability of temperature; (4) the intensity of light.

I will now give some examples of the occurrence of anophelines in houses. It was hoped that some numerical records, similar to those obtained for cowsheds, etc., could be obtained for houses in the areas, but, owing to the reluctance of the British householder to admit a stranger into the bedrooms and other private portions of his house, time after time this was found to be impracticable. However, at each visit to the areas I endeavoured to stay at a house within the area, and in these cases some interesting results were obtained.

At Great Wakering the house at which I stayed, during the visits from April to August, was situated in the centre of the fields of a market-garden, and mosquitoes of various kinds were to be found swarming in the fields around the house on suitable evenings, and *A. bifurcatus* was particularly numerous at times. Yet on no occasion was any anopheline found in the house until the last day of the visit, about the middle of August, when, as I was sitting at breakfast, about half-past eight, a female of *A. plumbeus* attempted to bite my left hand, which was resting on the table.

Another case of interest occurred at New Romney. The house at which I stayed there was a detached one, surrounded by a garden, and the latter adjoined the yard of the Station Hotel, in which was a large stable where *A. maculipennis* abounded. The bedroom I occupied overlooked the garden on the hotel yard side, and the window was invariably left open, but in spite of the close proximity of numbers of *A. maculipennis* none were observed in the bedroom during the visits made in April, May and the beginning of June. However, on the 25th June I was awakened at 5 a.m. by the buzzing of a mosquito, which eluded capture at the time, but in the morning a female *A. maculipennis* containing blood was found on the wall. At the next visit, about the middle of July, quite a series of invasions took place. On the morning of the 16th July, a female *A. maculipennis* was found in the room, and there was a mark on my forehead which was possibly a bite. The next morning four males and seven females were found in the bedroom. Irritation of the head and face had been noticed in the early morning, but no bites were visible when I got up. The insects were left undisturbed, and by the morning of the 18th only four females remained, the others having left during the previous evening and night. A mark of a bite was noticed on the left thumb.

A further case of interest was an attempt by two females of *A. maculipennis* to bite me whilst I was changing in my bedroom at the Station Hotel, New Romney, at 4.30 p.m. on the 9th October.

Colonel JAMES has dealt at some length with the cases of malaria at Queenborough, and on the 24th September I examined, through the kindness of Dr. SEELEY, a number of the houses in which cases of malaria had occurred. *A. maculipennis* was found in many of the houses, especially on the ceiling of the landings.

What, then, are the factors which control the invasion of houses by *A. maculipennis*? My own view—arrived at rather from general considerations, and probably subject to modification as our knowledge of the subject increases—is that the invasion of houses is associated with the swarming, for pairing purposes, of the insect. The operation of pairing completed, the immediate object of the females is to seek a meal of blood and the males a hiding-place for the coming day. It is known that *A. maculipennis* swarms usually at a height of twenty feet or so from the ground, and if the swarming-place happens to be close to the open window of a bedroom containing a human being, it is natural for both males and females to enter it in pursuit of their various objects. Whether they will stay there for any length of time depends upon whether the room or the house is suitable or not, and now the factors which have been enumerated above in connection with the observations on the cowsheds come into operation. This appears to me to offer a feasible explanation of the findings at Queenborough. The houses examined were nearly all built on a particular plan. The entrance hall gave place to a staircase which led up to a central landing, from which the bedrooms at either end and along one side opened. The ceiling of this landing supplied three of the four factors, viz., absence of draught, stability of temperature, and, when the bedroom doors were closed, diminished lighting, in fact, almost complete darkness. The people occupying the house would serve as a substitute for the first factor. This may explain why the insects were found in such a large percentage of cases, and, combined with the records from the cowsheds, certainly supports Colonel JAMES'S view that the insect does not stray far from the place where it obtained its first meal of blood except for the purpose of laying its eggs.

Hitherto all the instances of biting given have concerned *A. maculipennis* and *A. plumbeus*, and in order to complete the series I will give an instance of *A. bifurcatus* biting. On August 14th I went, together with Mr. R. F. BURTON, into a pine wood on his estate at Longner Hall, Salop. Almost as soon as we had settled ourselves in a spot near a small pool of stagnant water we were attacked by numbers of various species of Ochlerotatus. After a while their attacks subsided, and then isolated females of *A. bifurcatus* were observed approaching, with a curious zigzag flight, evidently intent upon a meal. During the time that we were there, 5.30 to 7 p.m. (summer time), four females were caught after they had attempted to bite us. Mr. BURTON informs me that he has had similar experiences with *A. bifurcatus* at different times, varying from eleven in the morning till evening. This observation is interesting because it throws light on the conditions under which *A. bifurcatus* may attack human beings, although it does not commonly frequent houses.

Other matters and details will, of course, appear in a report to the Local Government Board, but I have selected these as bearing on some of the points mentioned by Colonel JAMES.

Surgeon-Captain P. W. BASSETT-SMITH: In 1917 there were nineteen cases of malaria contracted in England reported from Naval bases. These were summarised in the Local Government Board's Report on Malaria (No. 119).

During 1918 I have had nine fresh cases reported in men who have never been abroad, or if abroad (two cases), never had previous attacks of fever—one left Australia in 1913 and the second was in the Mediterranean in 1916.

One case, in a boy, was contracted at Shotley, in Suffolk, near Harwich. It is stated that mosquitoes were at the time abundant in the low-lying marshes, and specimens of *A. maculipennis* were sent to me. The fever was of an intermittent type. He was the only one affected, and on enquiry no cases of malaria nearer than Southwold (twenty miles

distant) were traced. The second case was an ordinary seaman from Burntwick Island, Sheerness. The man had been in the Mediterranean in 1916, but had never been ill. He was employed on shore at the time and mosquitoes were troublesome. Five of the other cases were from the Isle of Grain, Kent, which returned eight cases last year. Marshland and stagnant pools, intersected with dykes, surround the station, and mosquitoes are generally abundant, and many living specimens were sent to me of *Culex pipiens* and *Anopheles maculipennis*. All but one case occurred in the early part of the year, April, May and June.

There were two cases from Eastchurch, Kent, both in September. This station returned six cases last year. It is surrounded by marshland and ditches, and in the hot weather swarms with mosquitoes.

There are six other cases which could be said to have definitely contracted the disease at the Isle of Grain in 1917, and relapsed or were reinfected during the year. All the cases were proved to be malaria by finding the parasite in the blood, which was always *P. vivax*.

The Naval Medical Officer of the Isle of Grain station states that undoubtedly cases of malaria have occurred in several of the villages around, and that splenic enlargement is an early and marked symptom of the disease. He quotes an instance of a family in which three were attacked by the fever, and he found in each an enlarged spleen. The cases tend to be very localised, those working in the shed of the Engineering Construction Camp being most affected, and in this area anopheline mosquitoes were frequently found. It is also noted that they were particularly abundant in the stables of a certain farm. He came to the conclusion that there was an endemic pre-war form of malaria in the district, as special precautions were taken to prevent the spread of the overseas type of infection, and an enquiry in September, 1918, shewed that there were only five old malarial cases on the station. These dated back to 1915, and none had suffered from recent attacks of fever, though, with a constantly changing personnel, infection might have been present from time to time, but none of the new cases were traced directly to any of these known forms. Cases which came under my treatment, however (sent on to the Seamen's Hospital, Greenwich), shewed frequent relapses and much anæmia, as is common in the Salonika infected men.

The prophylactic measures taken were: every case as soon as diagnosed was given quinine, put under a mosquito net, and drafted as soon as possible to hospital or to a non-malarial station. Any rating known to have a history of recent malaria is immediately sent out of the station.

Every endeavour was made to destroy the larvæ by paraffining the pools, etc., around the living quarters, and the edges of these were kept free from long grass, but, the area being so large, it was impossible to do more than this.

With regard to the cases which were contracted on the station in 1917, and either relapsed or were reinfected in 1918, the time of onset in all was the early part of the year. In most of these cases the previous attacks were not diagnosed or reported at the time.

TABLE.

	Cases.	Onset.					
		April.	May.	June.	July.	Aug.	Sept.
Shotley ...	1	—	—	—	—	—	1
Sheerness ...	1	—	—	—	—	1	—
Eastchurch ...	2	—	—	—	—	—	2
Isle of Grain	5	1	2	1	—	—	1
	9	1	2	1	—	1	4
Relapsed or Reinfected Cases.							
Isle of Grain	6	1	3	2	—	—	—
Sheerness ...	1	1	—	—	—	—	—
	7	2	3	2	—	—	—

Captain Angus Macdonald, R.A.M.C. (T.): To achieve coherent realisation of malaria indigenous in England requires appreciation of three main factors of infection—the infective carrier, the soldier returned with malaria from endemic country; the transmitting vehicle, the anopheline mosquito in England; and the victim, soldier or civilian, who has not been out of this country or has not been infected with malaria in any country.

Confining consideration to malaria, imported and indigenous, amongst troops in England, I present briefly the facts of importation, transmission and indigenous occurrence recorded, in their connection, during the period 1916 to 1918.

With the factors of infection the conception of prevention is inevitably linked up, and brief reference will be made to the modifying influence of preventive measures on indigenous incidence.

Therapeutics, coming as it were after the event, I leave alone.

I. Malaria Carriers.—With the return, in the winter of 1916–17, of Expeditionary Force men from Eastern seats of war, came the anticipated recognition of relapsing malaria; and in April, 1917, the special control instituted by the War Office definitely, by the issue of Provisional Instructions for Treatment, directed the care of sufferers from malaria.

These instructions had in view the wise and efficient treatment of men and their refitting, as well as the safety of other troops and civilian populations. Already in January, 1917, centres in the Commands had been selected for special treatment of malaria cases; but it had not been considered administratively justified that the fact alone of having suffered from malaria, or of being probably liable to relapse, should prevent men discharged from hospital from returning in natural course to their units. From the start, therefore, malaria carriers were distributed in the Commands throughout the country.

The further expectation of the occurrence in England of indigenous malaria was realised in the autumn of 1917, and with the guidance of these occurrences it was determined by the War Office, in consultation with the Local Government Board, to schedule as "dangerous areas" those districts in which cases had arisen, embraced chiefly in Romney Marsh, in Sheppey and the Isle of Grain, and in Sandwich. For reasons of prevention, special provisions, in addition to those already in operation, were agreed on for control in these dangerous areas, to be applied to other districts if occasion should arise by extension of the occurrence of indigenous malaria.

In July, 1918, it was considered advisable to remove malaria carriers from dangerous areas, and in August it was further decided to concentrate all malaria carriers in the Commands at home for transference to France, where camp conditions were available more readily than in England for aggregation and localised control. It is probable that before these removals were effectively consummated, any breaches in the preventive armour had been taken full advantage of by *Anopheles maculipennis*.

The distribution in the months May to September, 1918, throughout the dangerous areas of actual known malaria carriers was :—

1918.	Sheppey and Isle of Grain.	Romney and Lydd.	Sandwich.
May ...	491	86	20
June ...	552	91	32
July ...	550	24	57
August ...	349	23	25
September	46	33	38

These figures are minimal, and the amounts are subject to individual interpretation of the designation "carrier," which arbitrarily implied all who had relapse within sixty days. Different camps carried varying strengths of returned malaria personnel who might be liable to relapse, and of different ranks amongst whom relapse if slight was not revealed. For instance, it has been notorious that amongst officers it was customary to "carry on" in spite of malaria relapse, which was usually self-treated; and at Lydd especially officers under training were in large number. On the grounds suggested, therefore, it is justly

assumed that the efficiency of the personal control of carriers was various and in general partial.

II. Anopheline Transmitter.—During 1917 and 1918 considerable addition has been made to the knowledge of the distribution in area and in numbers, and the habits of the Anophelinæ throughout England, Scotland, Ireland and Wales. Much is yet to learn.

Precise detail of observations is elsewhere recorded. Here and now it may be permitted briefly to summarise observations, mainly personal, and inferences tentatively arrived at for purposes of preventive administration, so far merely as they bear on the matter of infection.

1. *A. maculipennis*, *A. bifurcatus*, and *A. plumbeus* have been found—*maculipennis* with great frequency and in greatest numbers; *bifurcatus* less frequently and fewer: and *plumbeus* rarely.

2. *Maculipennis*, adult, is found the whole year round; it may be called the domestic mosquito, its winter dwelling being in the warmth and shade of occupied stable buildings and its warm weather wanderings bringing it in contact with man in the home.

3. *Bifurcatus* is a creature of the open, rarely coming into human dwellings.

4. *Plumbeus* is sylvan, breeding in tree holes.

5. Probably the usual food of the female of all three is the blood of animals; *maculipennis* has been taken frequently feeding on cattle in stables.

6. All have been recorded biting man.

7. *Maculipennis* (adults and larvæ or potential breeding-places) has been found in immediate association with each case of indigenous malaria recorded. *Bifurcatus* and *plumbeus* have not been found in such association.

8. *Maculipennis* alone is found in any number in human dwellings, and from its habits is accepted as the most probable usual transmitter of malaria in England.

9. Comparative observation shews no difference of distribution and incidence of *A. maculipennis* in the years 1917 and 1818; and meterological conditions differed but in slight degree.

III. Indigenous Malaria—Occurrence in 1917.—The cases of indigenous malaria recorded amongst troops in England during 1917 number 163. Obviously this is a minimal record.

An individual investigation of these occurrences in 1917 was not undertaken personally by specialised officers; detailed criticism of indigenous cases is confined to those arising during 1918 when individual investigation was undertaken.

Occurrence in 1918.—A record is presented of 61 cases of indigenous malaria occurring amongst troops in England in the year 1918, containing brief detail in tabulated form of the points essential to the determination of the infection and of indigenous origin:—1, Serial Number; 2, Regt. No.; 3, Rank; 4, Name; 5, Unit; 6, Location at date of onset; 7, Probable location of infection; 8, Residential history; 9, Malaria history; 10, Evidence of infection; 11, Infection factors (*a*) carriers, (*b*) mosquito, (*c*) larvæ and breeding-places. With the exception of No. 8 the cases have all been personally investigated by the recorder, the others by other responsible officers.

Some consideration is offered of these indigenous cases and of the factors of endemicity in England.

Evidence of malaria has been established by expert pathologists.

Evidence of indigenous origin has been accepted or established by the recorder after exhaustive epidemiological criticism of all factors known to be concerned.

The *Infective foci* have been assumed to number 29—a minimum.

The incidence and distribution in the years 1917 and 1918 are shewn in Table I.

The *Seasonal Distribution of Indigenous Occurrence and Infection* is presented in Table II.

In Table III. evidence is to be found bearing on facts and assumptions relating to indigenous occurrence in 1918.

There is apparently undeniable evidence of infection in early May. From the recorded temperatures, and from the estimated temperatures, over thirteen 16-day periods

from 19th April, anopheline plasmodial development under natural conditions would have to take place at temperatures ranging from 44° F. to 51° F.

Adventitious incubation within heated military huts is postulated and was probable in all four cases. In June and July the few cases occurring may have had similar origin. It may be noted that May and August infections are definitely recognised in temperate countries. June and July supply few cases. Assuming in a temperate country the necessity for incubation at indoor temperature of heated rooms to produce May infections, it is evident that social custom would explain the rarity of infection in the June and July months, in which ordinarily fires will have been left off in dwellings. By August, normally, anopheline plasmodial development finds ample temperature for occurrence.

The possibility of *accidental infection* by transfusion of blood of a malaria carrier has in all cases been eliminated.

Endemicity of Malaria in England.—Definitions applied to malaria :—

1. *Indigenous* implies simply origin in the country.

2. *Endemic* means belonging to the country, and the use of the term demands that all factors causative are always and can be naturally present.

3. *Autochthonous*—frequently used by French writers—implies even a closer association than aboriginal with the country. The term is quite inapplicable to malaria, but might, for all we know, apply to *A. maculipennis*.

4. *Epidemic* is wide incidence in a point of time of infectious disease.

From evidence accumulated it is suggested here that the factor definitely determining the occurrence of malaria in England is the importation of carriers; that at the present day there is no evidence to support the belief that malaria is endemic (as defined, or continuously endemic) in England; that the evidence accepted to demonstrate that malaria at one time was endemic in England, may equally be taken to prove that it depended for its reappearance on the importation of carriers; and that while excessive importation of carriers may from time to time give rise to an outbreak of indigenous malaria, the absence from continuous operation of one of the infective factors will prevent the establishment of malaria endemic in England.

The last previous recognition of malaria in epidemic form was in the years 1857 to 1859. In 1856 and later years there is evidence of large importation of ague especially from Eastern Europe. The coincident abnormal elevation of temperature in the summers of 1857–1858–1859 enhanced infectivity, and recognised epidemics occurred.

Malaria seems quickly to have disappeared after 1860, when summer temperature receded.

Spontaneous and therapeutic recovery from malaria takes place in a definite, but not established, percentage of cases infected in a period short of eleven months. Eleven months—August–September to July–August—are in general required for the vital continuity of malaria infection under normal meteorological conditions in England. Under these normal conditions there is evidence that the carrier volume brought forward from year to year is insufficient to maintain malaria endemic in England. Hence the immunity of the past sixty years, over which we can cast the seeing eye.

The *importation of carriers* determines the *fact* of indigenous malaria; *protracted elevation of temperature* coinciding determines the incidence. Extensive epidemic will result from an optimum of coincidence.

IV. Preventive Measures—Quinine Administration.—As a prophylactic, quinine has not been used or recommended officially in England.

Screening. Huts have been screened for the segregation of malaria carriers on all camps in recognised dangerous areas. Screening has varied in satisfactoriness. There is no record of *maculipennis* being found within screened huts at Sandwich. At Sheppey, *maculipennis*, male and female, have from time to time been taken in small numbers in screened huts.

It has been stated above that evidence suggests that, for various administrative reasons, it may be accepted that in all camps some carriers escaped detection and segregation within screened huts.

Pathological Work.—Expert means of ready diagnosis were provided in all areas concerned, and prompt recognition of case and carrier distinctly aided prevention.

Entomological Research.—To enhance the value of field observations, which have been systematically pursued by various officers, an experimental entomological laboratory has been carrying on work, of which the results will appear in due course.

Anti-mosquito Measures.—These consisted of direct attack on the adult *A. maculipennis* in its winter haunts and throughout the year in all haunts, and on the breeding-places of *maculipennis* and *bifurcatus*.

For administrative reasons it was found possible to deal with the Sandwich area with a directness and completeness not readily applicable to other areas. *The results obtained at Sandwich are claimed to issue from the more intensive sanitation there carried out*—See Table I.

The local records of mosquito presence, the general expression of diminution of nuisance, and, most of all, the morbidity record in face of increased infectivity, demonstrate again that deliberate and sustained attack on the transmitter is the way to deal with malaria.

Give the Sanitarian a chance, and the Therapeutist will find malaria removed from his consideration.

Summary Conclusions.—1. There is evidence that malaria has occurred in the British Isles in past times.

2. There is evidence of the occasional local extension of malaria to epidemic magnitude.

3. There is evidence pointing to the absence of continued endemicity of malaria from the British Isles.

4. All factors essential to the continued endemicity of malaria are not continually present in the British Isles.

5. The brevity of the annual infective period, together with the protracted period between each annual infection time, within which spontaneous and therapeutic recovery may take place, prevent continued endemicity.

6. Malaria, indigenous, but locally discontinuous, may be maintained year by year by the sporadic importation of "carriers" under normal conditions of movements of population.

7. Under conditions of extensive importation of carriers wide infection may suffice to produce epidemic, which, owing to causes specified in statement 5 above, will subside with rapid progression in seasons.

8. Epidemic occurrence and continuance depend upon a coincidence of factors, the optimum of coincidence being—

(*a*) Large importation of carriers to anopheline areas;
(*b*) Ample incidence of anophelines;
(*c*) Abnormally high temperature and its abnormal continuance;
(*d*) Association of "carriers" with susceptible populations.

9. In any defence against malaria in the presence of extensive importation of "carriers," sanitary measures directed to the limitation of the anopheline are of proved paramount importance.

TABLE I.

COMPARISON OF INCIDENCE AND DISTRIBUTION IN 1917 AND 1918.

Situation.	1917. Number of Cases.	1918. Number of Cases.
Sheppey ...	68 ...	31
Isle of Grain ...	3 ...	3
Sandwich ...	69 ...	6
Lydd	1 ...	2
Aldershot ...	4 ...	4
Elsewhere ..	18 ...	15
	163	61

TABLE II.

SEASONAL DISTRIBUTION OF MALARIA OCCURRENCE AND INFECTION.

OCCURRENCE.		INFECTION.	
Date, 1918.	No. of Cases.	Probable Date	No. of Cases.
May ...	3	May ...	4
June ...	2	June ...	2
July ...	1	July ...	3
August ...	22	August ...	47
September..	29	September..	4
October ...	4	October ...	1
	61		61

TABLE III.

	STATION A, EAST COAST.				STATION B, MIDLANDS.		
1918.	Max.	Min.	Mean.		Max.	Min.	Mean.
May ...	60·9	47·2	54·0	...	63·7	43·9	53 8
June ...	63·9	48·4	56·0	...	64·9	44·6	54·7
July ...	66·8	53·7	60·2	...	67 7	50·7	59·2
August ...	68·0	55·1	61·5	...	69 3	51·9	60·6

Mr. A. BACOT: I would suggest, with regard to temperature tables in connection with malaria in this country, the importance of recording the *maximum*, together with some indication of the *period* during which the day temperature is high enough to allow of the development of Sporozoits within the mosquito.

The mean temperature may convey an erroneous impression in clear sunny weather, when hot days are followed by cold nights. Such conditions, while greatly lowering the mean, would probably only delay and not prevent development of the malarial parasite, as would be the case in cloudy weather, when cool days are followed by a relatively small night fall of temperature.

In connection with Captain MACDONALD'S communication, the question occurred to me as to whether there is a possibility of the feeding instincts of *A. maculipennis* having altered within historic time in accordance with the extensive change that must apparently have taken place in the sources of its food supply. Prior to (say) the seventeenth century, the hibernating females must have been much more restricted to human blood than is now the case, when stalled horses and cattle are frequently more numerous in proximity to their haunts than human habitations. It would be interesting to test by experiment whether mosquitoes, hibernating in stables or cowsheds, are as eager to attack man as those living in human habitations.

Sir RONALD ROSS: I do not suppose that Colonel JAMES considers that the hypothesis that there are two strains of benign tertian parasites now in England is to be taken as proved; but he has been quite right to make this very interesting suggestion, and I hope that further investigations on the matter will be made. For example, I would suggest that Captain JOHN THOMSON, R.A.M.C., who has been recently doing much cultivation work on the malaria parasites, should be asked to make cultures of the two suggested strains, in order to see whether there is any morphological difference. I might suggest, also, that volunteers may be found who would be willing to be inoculated!

The second point in Colonel JAMES'S paper concerned the "spring rise" in malaria. This is of course an old story. The Italians observed it many years ago, and hence called benign tertian by the name of "spring tertian." They shewed that there is always an increase of such cases in March and April, long before the anophelines begin to bite. Subsequently I examined very carefully the Indian statistics, and found a similar rise occurring almost everywhere in the months of February and March, also before the Indian anophelines begin to bite. I made a special study of the conditions in the

Punjab in India, where this phenomenon is marked, and I discussed the matter in my book on "The Prevention of Malaria." Recently Captain ANGUS MACDONALD has given, I believe for the first time, what appears to be the true explanation, namely, that at this season the mosquitoes, which are now ready to come into active service at the beginning of the spring, are encouraged to do so by the heating of the houses. It was previously thought that this spring rise was due to the hibernating mosquitoes remaining infected during the whole winter, but recent observations in Salonika suggest that this is not at all true.

I regret that owing to the lateness of the hour I cannot say more about Colonel JAMES'S interesting paper.

MALARIA, WITH REFERENCE TO

(1) THE DANGER OF IMPORTED ANOPHELINE INSECTS,

(2) AN UNUSUAL BREEDING GROUND.

BY

L. BOUSFIELD, M.A., M.D. (CANTAB.), M.R.C.S., L.R.C.P., D.P.H.

Medical Officer of Health, Khartoum and Omdurman.

I.

This article deals with the malarial problem in Khartoum, a town which is situated at the junction of the Blue and White Niles, and which has a hot and dry climate with a very small rainfall.

The Southern Sudan is highly malarious, while the Northern Sudan, until recent years, was not nearly so much infected; but the steadily increasing number of pump irrigated farms and the very high Nile of 1917 converted it into a very hot-bed of malaria in that year.

The natural sources of infection for Khartoum are—(1) River pools, (2) garden and household collections of water, (3) wells, (4) rain-water pools, (5) irrigated farms.

The rain, though very small in total aggregate, comes in a few heavy storms, which often flood streams and produce many pools which may last weeks.

Besides the five sources mentioned, there is a large traffic in steamers, native boats, and trains coming from highly malarious districts.

Before preventive measures were adopted there is abundant evidence that Khartoum was intensely malarious, but since steps, first inaugurated by Lieut.-Colonel ANDREW BALFOUR, C.M.G., while M.O.H., have been taken to deal with the problem, the town has been kept remarkably free from malaria, and a mosquito is rarely seen or heard.

The total population of Khartoum and Khartoum North is about 33,000, and the recorded malarial cases have been taken as follows:—

Oct. 1st to Sept. 30th.	Khartoum.	Khartoum N.	Total.	Approximate Incid'ce per 1000.
1911–1912 ...	56 ...	19 ...	75 ...	2·27
1912–1913 ...	31 ...	16 ...	47 ...	1·40
1913–1914 ...	51 ...	17 ...	68 ...	2·06
1914–1915 ..	58 ...	16 ...	74 .	2·24
1915–1916 ...	5 ...	2 ...	7 ...	0 21
1916–1917 ...	109 ...	14 ...	123 ...	3·75
1917–1918 ...	264 ...	36 ...	300 ...	9·09

The records from 1911 1916 are highly satisfactory, while the increases for 1916 to 1918 were produced by—(1) the high Niles, especially that of September, 1917; (2) the great increase in native craft bringing in wood, due to the shortage and exorbitant price of coal.

The number of native boats now bringing wood into Khartoum is about forty-five to every one prior to the war.

These boats nearly always come from highly malarious districts, and journey slowly down or up the river to Khartoum, often tying up to the banks during the night.

Thus anophelines come on board to feed off the crew, and, when fully gorged, seek

the nearest shelter, which in most cases is the cargo, especially wood cargoes, where they remain undisturbed until unloading occurs.

The anti-malarial measures adopted are briefly given :—

(1) The towns are divided into areas, to which a man of the mosquito brigade is appointed.

He inspects weekly every house, garden, well, etc., in his district.

(2) Every adjacent farm is inspected weekly.

(3) All the river banks and pools are inspected weekly.

(4) Mosquito clearance stations have been formed on the Blue Nile, east and west of Khartoum, and every river craft has to call for inspection, the clearance of water and live mosquitoes, when possible by SO_2 gas, or cresyl, and an attempt is made to bolt mosquitoes from exposed cargoes by smoke producing machines.

(5) The prosecution or imposition of a fine in every instance when mosquito larvæ more than three or four days old are found in domestic utensils, etc., or in places where ordinary care would have prevented their occurrence.

The fine imposed usually corresponds to about 10s.

(6) Constant check inspections are made by the British Staff to see that the work is thoroughly done.

Except under such circumstances as a very high Nile or very extensive rains, Khartoum can be, and is, kept practically free from malaria, and, were it not for the imported infective insect, the records would be much more satisfactory, and it is to call further attention to the importauce of such sources of infection, in places where active anti-malarial work is done, and where the success is to some degree nullified by the advent of such insects, that this article is written.

The more one studies the malarial problem the more one is forced to recognise that in combating the source of the disease the battle must not only be fought locally but must be extended to regions far beyond what has been, and often still is, regarded as sufficient, and when traffic from highly infected regions exists the imported imago has to be reckoned with.

The following facts are recorded dealing with imported mosquitoes : —

(1) The area of Khartoum and Khartoum North adjacent to the river is far less densely populated than that further away, and yet the former has supplied a far greater number of malarial cases than the latter.

For instance, between October 1st, 1916, and January 20th, 1917, there were ninety cases, believed to have been locally contracted, of which fifty-five occurred within 150 yards of the river bank amongst 2,900 inhabitants, while of these there is evidence that thirteen or more occurred from a flight of mosquitoes from a wood boat, and that of the remaining twenty-two it appears highly probable that six were contracted through infective mosquitoes brought in by trains. We have demonstrated on several occasions the presence of mosquitoes in incoming trains.

During the period under consideration the wind is blowing from the northern direction, thus causing Khartoum to be more affected than Khartoum North.

The sources of infection might be neglected breeding places in pools, gardens, houses or steamers and boats ; but for ten months in the year mosquitoes are practically never seen, yet all these sources are present all the year round, except that the steamers and boats, though running all the year round, are more numerous with the high Nile, and are found only to harbour anophelines to any degree during the period when breeding places exist in large numbers outside the controlled area.

(2) During the period just mentioned river craft are often found, when passing through the clearance stations, to harbour considerable numbers of anophelines

They are very rarely found to be breeding on board, though culex and stegomyia frequently do so.

The anophelines are nearly always females, and undoubtedly come on board for human blood, and not to breed.

Except in holds and cabins, which can be closed and fumigated, the problem of how to deal with them efficiently, and at a reasonable cost, is very difficult : at present we try to bolt them with smoke outside the town.

The map shews that cases tend to collect round unloading stations, which are marked X.

(3) Many times it has been found that a few mosquitoes appear in a house near the river bank, which has been free from them for months, and this has almost invariably coincided with the advent and tying up of a steamer or native boat opposite to the house, while no local neglected breeding places could be found on most thorough examination.

For instance, on March 14th, 1918, two very large barges, ladened with wood, arrived opposite the Burri Water Works, having come from the White Nile, which was at that period teeming with mosquitoes.

Prior to this, for some considerable time very few mosquitoes had been noticed at the waterworks, but immediately after unloading was commenced mosquitoes appeared in considerable numbers.

The Chief Engineer's servants' quarters are immediately opposite the unloading place, and in their bedroom we found -

On March 16th, 18 female anophelines :
" " 17th, 7 " "
" " 18th, 5 " "

and after this date only one every few days, and within ten days all had disappeared.

In the adjacent houses very few could be found.

We have found wire mosquito flappers the best method of killing off such mosquitoes, and during the winter of 1917, and early in 1918, two men were employed daily to visit all servants' rooms and the latrines along the front ; by this means large numbers were killed off.

Curiously, in the latrines, quite ninety per cent. were male culices, the female culex being seldom found, and the anopheline but rarely.

This observation has been often corroborated locally, and the love of the male culex for the latrine bucket appears to strongly indicate that the male culex loves feeding off human excreta if he gets the opportunity.

(4) The mosquitoes known to breed locally are *Pyretophorus costalis*, *Culex fatigans* and *Stegomyia fasciata*.

Species, which do not breed locally, have been found in houses near the river banks and in incoming trains :—

(a) Tæniorhynchus.

(b) Cellia pharoensis.

(c) A very large, dark coloured culex, unidentified at present, but known to be a marsh breeder.

(5) One very instructive example of malaria caused by anophelines from a wood boat is now recorded. (*Vide* Plan I.)

On December 22nd, 1916, malaria began to appear amongst the soldiers of the Military Works Department and the Sirdar's escort.

Ten cases appeared between December 22nd and January 2nd, and then the outbreak abruptly stopped.

This area is inspected weekly, and a very careful check inspection failed to shew any neglected breeding place.

About the same time two small epidemics occurred amongst the British troops and the Egyptian battalion at Said Pasha Barracks.

Ten British soldiers developed the disease between December 19th and January 3rd, and then the disease claimed no more victims, while eight cases occurred at Said Pasha Barracks between December 22nd and December 30th, and then no more cases appeared.

Careful inspection revealed no missed breeding grounds, and Said Pasha Barracks lies surrounded by desert.

No pools were found to have larvæ more than two or three days old, and the farm on the other side of the river was found to be free.

It appeared possible that these three little outbreaks were connected, and investigation elicited the following facts :—

On December 7th a muggar, loaded with wood, having evaded the Mosquito Clearance Station, arrived opposite the Military Works Department, and was unloaded by the soldiers between 2 p.m. and 6 p.m. on that day.

The wood had come from a highly malarious place on the Blue Nile.

Now the only bodies of men living near this unloading station are:—(1) The Military Works Department; (2) Sirdar's escort: and both were infected.

The civil public works department buildings are immediately opposite the unloading station, but are unoccupied at night, except for two watchmen, one of whom went down with malaria.

Pools, owing to the falling Nile, had commenced to form late in November opposite the Burri Waterworks, a little E.N.E. of the British barracks, but were kept under supervision.

On December 9th thirteen pools were found to be heavily infested with anopheline larvæ two to three days old.

On following up the history of this wood boat we found it had tied up on the evening of December 6th opposite to these pools, and had remained there until the morning to pass through the bridge.

At this date the wind was blowing from the N.E., and there can be no doubt some mosquitoes flew on shore, some laying eggs in these pools and causing the cases of malaria, namely, two at the Burri Waterworks, ten at the British barracks, all occurring in the N.E. portion, and that some flew on to Said Pasha Barracks across the desert, some 1,000 yards distant, but only infected two rooms (*Vide* Plan I.), these, except for one, being the nearest to the British barracks.

It will be noted that the first occupied room, *A*, was unaffected, though 95–100 men sleep here, and the reason was because the N.E. windows, facing direct to the wind, were kept closed, while the windows of *B*, being sheltered from the direct effects of the wind by the projecting room *A*, were left open.

The windows of room *C*, facing N.E., were also kept closed, but there is a large arched opening between rooms *B* and *C*, allowing mosquitoes to pass freely from one to the other.

Room *B* developed five cases, four being near the most north-easterly window, while room *C* only developed three cases

Rooms *D* and *E* were not affected, proving the well-known tendency of the mosquito to seek the nearest occupied dwelling.

In all these epidemics the malignant tertian parasite was present.

It seems probable that farther on in the town five other cases were caused by stray mosquitoes from this source, as they cropped up singly at this period and no local breedings out could be discovered; and, further, if due to a local breed out, the cases would have been more numerous and grouped together.

Six cases of malaria occurred in the railway employees' quarters during these four months, and these were almost certainly due to infective anophelines brought in trains.

II.

"*An unusual and, it is believed hitherto unrecorded, type of breeding place of the anopheline mosquito* (probably *Pyretophorus costalis*)."

The inundation around Khartoum, caused by the Nile flood of 1917, was very extensive, and totalled many square miles.

Tuti Island was largely flooded, and would have been almost completely submerged but for ramparts thrown up to keep the flood from the pump cultivated area.

The south-easterly portion of this island consists of large sand dunes with extensive intervening hollows. (*Vide* Plan II.)

The Nile reached 16·83 on September 22nd, and again on September 27th, from which date a very rapid fall took place for some weeks, but by the end of November the river level was being maintained fairly stationary.

The rapid fall drained off the large lakes that had been formed between the sand dunes and many of the pools, while we were able to deal with those remaining so as to render them harmless.

However, the amount of water sucked up and contained by the sand dunes must have been very considerable.

As the river fell large sand and mud banks appeared, but, except in one place, they all rapidly hardened on the surface, leaving scattered pools here and there.

At this one spot a large mud flat formed, some 150 yards long by some 30 yards broad.

Now the silt brought down by the Blue Nile in flood is very fine, and remains in suspension in the water for a very long time, and thus produces such a fertile plain as that of Egypt.

This mud flat was formed by this fine silt, and was of the consistency of thick pea soup.

It was not connected with any pool, there was no visible water, though the surface glistened in the sun.

On entering it one's feet went through without appreciable resistance until one was above one's knees in mud.

On taking up the fluid in a vessel it remained as fluid, and for a very long time.

Plan II. shews a rough section and plan of this flat.

The place was not examined for mosquito breeding, as it was concluded it was not a suitable breeding place; but on November 24th, 1917, one of the mosquito brigade men, while examining the pools on the island, tried to take a short cut by wading through this mud flat.

As he floundered through his dipper happened to enter the mud, and by force of habit he looked at the contents, and was surprised to find an anopheline larva five to six days old.

He carefully cleared the dipper and took other specimens, and found several more larvæ of different ages.

Mr. MURRAY, the Chief Sanitary Inspector, after confirming their presence, reported it to me, as the condition seemed a very difficult one to deal with.

I visited the place, and anopheline larvæ of various ages were found in considerable numbers, and this was confirmed later on, in the presence of Major R. G. ARCHIBALD, D.S.O., of the Wellcome Tropical Research Laboratories, and Mr. H. KING, the Government Entomologist.

On November 29th anopheline pupæ were found in fair numbers.

The question arose how one was to deal with this breeding ground, as both larvacide and oil tended gradually to spread on the surface and then slowly moved down towards the river, as the mud flat very gradually shelved in this direction. The perpetual and continuous spraying of oil or larvacide would soon have run into a very large sum at war prices; besides our stock would not have allowed of such a procedure.

Consequently I had a trench dug round the whole periphery, just outside of the mud flat, so as to try and intercept the water flow, and in doing this we came across the secret of the mud flat.

After digging through some ten inches of earth we came to a sand stratum, and some two feet below this a rocky stratum, which passed out from the island towards the river and is apparently restricted to this site.

In the deeper portion of the sand water gushed out like a spring the whole length of the canal adjacent to the island, and was undoubtedly fed and maintained by the vast amount of water still being given up by the sand dunes and island.

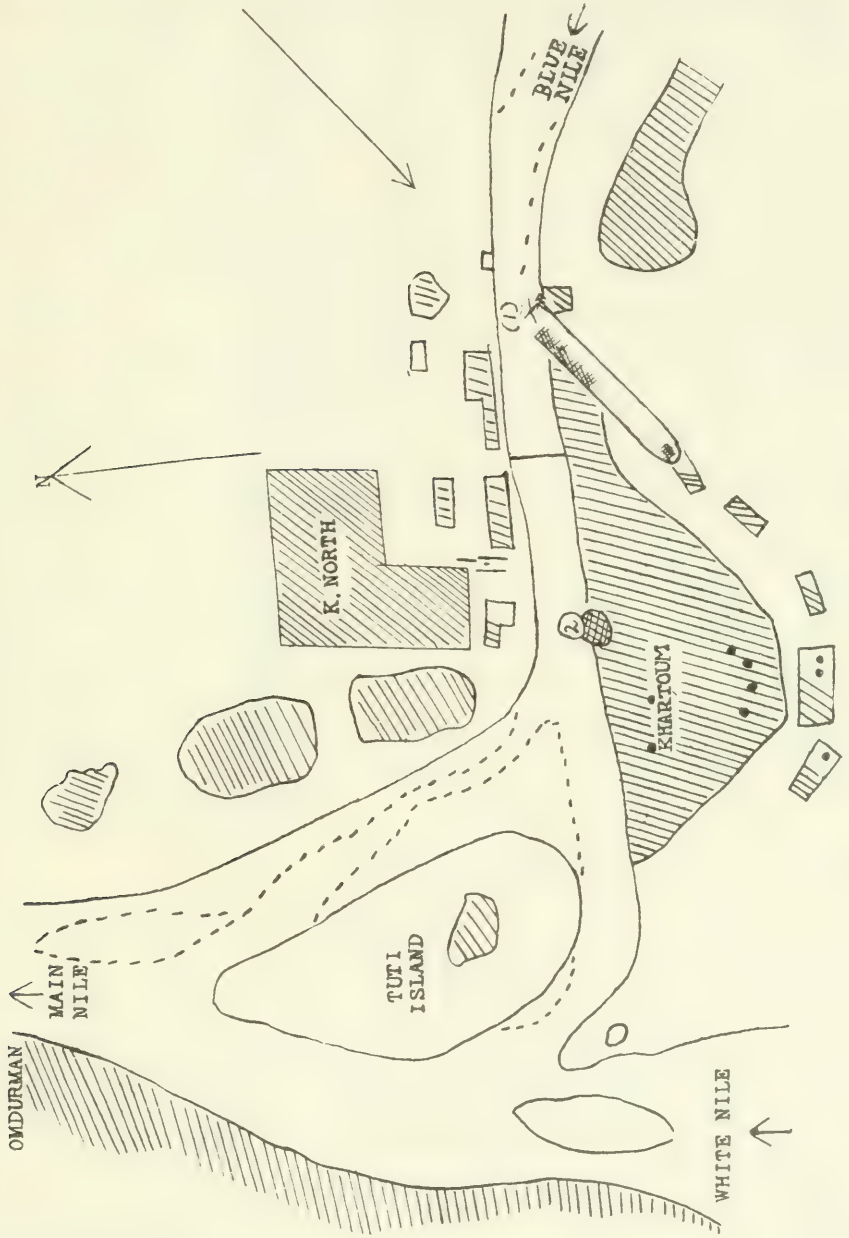
Elsewhere, there being no rocky stratum, the water took a deeper level, enabling the sand or mud to consolidate on the top and form banks

It appears probable that the rocky stratum has a slight slope from the periphery to the centre, thus forming a shallow basin and allowing the water to escape but slowly to the river.

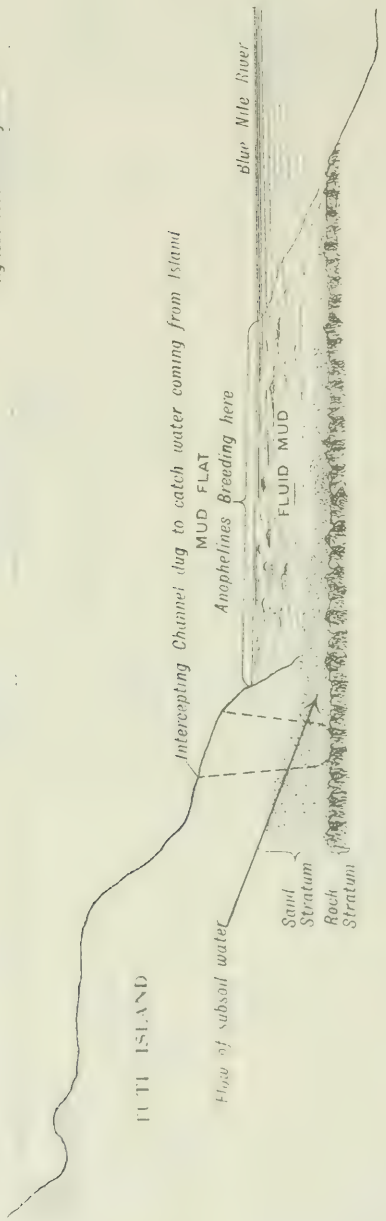
Major E. E. AUSTEN, of the British Museum, kindly wrote to me about this, and from his letter I understand such a breeding site has not before been described.

After digging the trench and intercepting the waterflow, and leading it off direct to the river, the flat fairly rapidly consolidated and dried up.

I regret we cannot definitely say whether anophelines bred out from this site, but if they could pupate, it appears probable that the adult insect could emerge from the pupal case. No attempts were made to breed out insects from larvæ or pupæ taken, but *Pyretophorus costalis* is the only anopheline which has been found to breed locally.



PLAN I.


Highest level 1917 flood
Blue Nile River
Intercepting Channel dug to catch water coming from Island
MUD FLAT
Anophelines Breeding here
FLUID MUD
Sand Stratum
Rock Stratum
Edge of subsoil water
TUTI ISLAND

PLAN II.

CORRESPONDENCE.

16th November, 1918.

THE REGISTRAR, COLLEGE OF PHYSICIANS,

SIR,

At a meeting of the Council of the Society of Tropical Medicine and Hygiene, held on 18th October, 1918, it was unanimously resolved, as a result of representations made by certain Fellows of the Society, to direct the attention of the Royal College of Physicians' Joint Committee, charged with the revision of the "Nomenclature of Diseases," to the following :—

1. From the point of view of tropical medicine there are a number of serious errors in the published List of Diseases.

2. There are likewise numerous important omissions, especially in the section dealing with Animal Parasites. As examples the Council may cite—

(*a*) The inclusion of two species of Simulium and *P. papatasii* (p. 234) as intermediate hosts of the malarial parasite.

(*b*) The omission of *Stegomyia pseudo-scutellaris* as a host of the filarial parasite (p. 235).

(*c*) The employment of the term "Mediterranean Fever" instead of "Undulant Fever," in view of the fact that the latter name was officially adopted by the International Congress of Medicine, held in London in 1913.

(*d*) The omission of an important intestinal parasite amongst the Flagellata, viz., *Chilomastix mesnili* (WENYON), p. 222

(*e*) The neglect to mention *Schistosoma mansoni* (SAMBON), a very important human parasite, whereas *Filaria gigas* (PROUT), which does not exist, finds a place in the list.

Many other instances have been brought to the notice of the Council. Attention may also be directed to the chapter on page 13, dealing with nomenclature. The rules there given do not correspond with those laid down in the International Rules of Zoological Nomenclature, nor with those adopted by the International Congress of Botany. Even such rules as are given are not followed in the examples cited by your Sub-Committee.

The Council of the Society of Tropical Medicine and Hygiene consider that it is regrettable that no authorities on tropical medicine were consulted on these and other important points before such a list was issued, and it trusts that when a further revision is contemplated, this oversight will be remedied.

DAVID BRUCE,

President, Society of Tropical Medicine and Hygiene.

Royal College of Physicians, London, S.W.

20th November, 1918.

DEAR SIR DAVID,

I beg to acknowledge the receipt of your letter of the 16th inst., drawing attention to errors in the revised edition of the "Nomenclature of Diseases."

I fear that nothing can be done to rectify errors in the present edition, but I will preserve your letter with the view of making alterations when that is possible.

I remain, yours faithfully,

J. A. ORMEROD,

Registrar.

Sir DAVID BRUCE, K.C.B., M.D.

6th November, 1918.

Le President, Société de Pathologie Exotique,

DEAR SIR,

The Society of Tropical Medicine and Hygiene congratulate the Fellows of the Société de Pathologie Exotique on the happy events that have recently occurred. They rejoice that the soil of France is free from the enemy, and that the progress of freedom is now assured. They feel that in the immediate future there will be a great revival in tropical medicine, in which France and Great Britain will play the leading part, and they hope that the two Societies will always remain united by the closest bonds of fellowship, and thus cement more firmly the Entente between the two countries.

We are, yours very faithfully,

DAVID BRUCE,
President.

GEORGE C. LOW,
ARTHUR G. BAGSHAWE,
Joint Secretaries.

Institut Pasteur, rue Dutot, Paris,

Le 17 Décembre, 1918.

Le Président de la Société de pathologie exotique de Paris au Président de la Society of Tropical Medicine and Hygiene, London,

MONSIEUR LE PRÉSIDENT ET CHER CONFRÈRE,

Au nom de mes collègues de la Société de pathologie exotique, je vous remercie des cordiales félicitations que vous venez de nous adresser à l'occasion de la libération complète des régions de la France qui étaient encore occupées par l'ennemi. A mon tour, je vous adresse nos bien sincères félicitations pour la part glorieuse prise par votre Nation à la victoire qui consacre le triomphe du droit et de la liberté sur la barbarie germanique. Je souhaite que l'entente cordiale entre nos deux Nations, scellée sur les champs de bataille, s'affermisse encore dans la paix, et que pendant longtemps nos Sociétés sœurs puissent travailler, de concert et avec succès, aux progrès de la pathologie et de l'hygiène exotiques pour le plus grand bien de l'humanité.

Veuillez agréer, Monsieur le Président et cher Confrère,
l'assurance de mes sentiments tout dévoués,

A. LAVERAN,

MARCHOUX,
MESNIL,
Secretaires Generaux.